Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

NATIONAL QUALITY MEASURES CLEARINGHOUSE

General

Title

Overuse of imaging: the percentage of computed tomography (CT) scans obtained without indication on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years old.

Source(s)

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: overuse of computed tomography scans for the evaluation of children with atraumatic headache. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC); 2016 May. 57 p.

Measure Domain

Primary Measure Domain

Clinical Quality Measures: Process

Secondary Measure Domain

Does not apply to this measure

Brief Abstract

Description

This measure assesses the percentage of computed tomography (CT) scans obtained without indication on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years old.

For the purposes of this measure, indications for CT imaging include thunderclap headache, vascular disease, infections, lumbar puncture, new neurologic deficit, or signs and symptoms of increased intracranial pressure. A lower percentage indicates better performance, as reflected by avoidance of CT imaging when it is not indicated.

Rationale

Headaches are common in the pediatric population (Lateef et al., "Headache in a national," 2009), and children with headaches are frequently evaluated in emergency departments and primary care settings (DeVries et al., 2013; Centers for Disease Control and Prevention [CDC], 2011). Although most headaches are not symptomatic of underlying disease, the differential diagnosis list for headache is long, with over 300 different types and causes (Evans, 1996). Headaches are divided into two main classifications: primary headaches, such as migraine or tension headaches, and secondary headaches, which include headaches attributed to a separate condition, such as infection, trauma, tumors, or vascular problems (International Headache Society [IHS], 2014). For the purposes of this measure, atraumatic headaches are considered to be primary headaches or secondary headaches unrelated to injury.

Computed tomography (CT) is a radiologic modality used to create images of internal structures in a slice-by-slice manner, using radiation generated from a high-voltage tube. Rationales for obtaining a CT scan to characterize headache include evaluation for suspected arteriovenous malformation or tumor, patient and parental anxiety about the potential for underlying vascular problems or tumor related to severe and/or recurrent head pain, and legal concerns for a missed diagnosis on the part of health care providers.

CT scans are simple to order because the technology is readily available (Ginde et al., 2008) and image acquisition is fast. However, CT imaging for children with a headache who lack any indication of trauma, intracranial hemorrhage, or other time-sensitive conditions yields little information (Hayes et al., 2012; Evans, 1996; Lateef et al., 2012; Lateef et al., "Headache in young," 2009) and exposes children to unnecessary risk from radiation. And yet, neuroimaging is increasingly used to evaluate children who experience headache (Broder, Fordham, & Warshauer, 2007; Graf et al., 2008; Larson et al., 2011). In its guidelines for imaging children with secondary headaches accompanied by neurological signs or symptoms of increased intracranial pressure, the ACR recommends magnetic resonance imaging (MRI); CT is suggested as an alternative in instances where MRI is unavailable or problems with sedation arise (Hayes et al., 2012).

This measure is focused on the overuse of CT in the setting of headache, a problem that has gained national attention in recent years (Loder et al., 2013). Overuse has been defined as any patient who undergoes a procedure or test for an inappropriate indication (Lawson et al., 2012). Imaging overuse subjects children to a number of risks (Malviya et al., 2000; Mathews et al., 2013; Pearce et al., 2012; Wachtel, Dexter, & Dow, 2009). Children who undergo CT scans in early childhood tend to be at greater risk for developing leukemia, primary brain tumors, and other malignancies later in life (Mathews et al., 2013; Pearce et al., 2012). Children are also at risk for complications from sedation or anesthesia, which are often required for longer CT imaging sequences. These complications include compromised airway, hypoxia leading to central nervous system injury, and death. Additionally, CT overuse creates cost burdens for the patient, as well as for payers.

Evidence for Rationale

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Primary Health Components

Atraumatic headache; computed tomography (CT) scan; overuse; children

Denominator Description

The denominator is the number of computed tomography (CT) scans obtained on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years of age (see the related Denominator Inclusions/Exclusions field).

Numerator Description

The numerator is the number of computed tomography (CT) scans obtained without indication on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years old (see the related "Numerator Inclusions/Exclusions" field).

Evidence Supporting the Measure

Type of Evidence Supporting the Criterion of Quality for the Measure

A clinical practice guideline or other peer-reviewed synthesis of the clinical research evidence

A formal consensus procedure, involving experts in relevant clinical, methodological, public health and organizational sciences

A systematic review of the clinical research literature (e.g., Cochrane Review)

One or more research studies published in a National Library of Medicine (NLM) indexed, peer-reviewed journal

Additional Information Supporting Need for the Measure

Headache Prevalence and Incidence
Headaches are common in the pediatric population (Lateef et al., 2009), and children with headaches are frequently evaluated in emergency departments and primary care settings (DeVries et al., 2013; Centers for Disease Control and Prevention [CDC], 2011). Headaches occur more often as children grow older (Hayes et al., 2012). At age 7 years, prevalence ranges from 37% to 51%. By age 15 years, 57% to 82% of children have experienced headaches. And among 16 year olds, 93% or more have reported experiencing a severe headache (Hayes et al., 2012). Before puberty, boys are more likely than girls to experience headache. The situation is reversed after puberty, when headaches are more commonly reported in girls (Hayes et al., 2012).

Headache Pathology and Severity
Headaches can be classified as either primary (not a symptom of an underlying disease, condition, or trauma) or secondary (related to an existing condition). Examples of primary headaches include migraine and tension headaches. Examples of secondary headaches include headaches associated with

dehydration, sinusitis, trauma, tumor, and vascular malformations. For the purposes of this measure, atraumatic headaches are considered to be primary headaches or secondary headaches unrelated to injury.

The precise pathophysiology of headaches is still not fully understood, but research suggests that complex interactions between the neural and vascular systems are involved (Edvinsson, 2001). The manifestation and perception of headache is unique and specific to the child who experiences it. Correspondingly, the management approach for children with headaches often focuses on reassurance and education by the clinician who evaluates the child (Brna & Dooley, 2006; Raieli et al., 2010).

Burdens of Overuse of Imaging for Primary Headache: Radiation, Sedation/Anesthesia, and Intravenous Contrast Risks; Cost

The literature offers many examples of the potential risks associated with overuse of imaging. Chief among these are risks related to radiation (Mathews et al., 2013; Pearce et al., 2012), sedation and/or anesthesia (Malviya et al., 2000; Wachtel, Dexter, & Dow, 2009), and intravenous contrast media (Zo'o et al., 2011). Cost is also an issue (Callaghan et al., 2014).

Radiation-Related Burden and Risk. Radiation exposure associated with computed tomography (CT)-imaging introduces the possibility of chronic health risks related to malignancies sustained from radiation effects (Berrington de González et al., 2009; Mathews et al., 2013; Pearce et al., 2012). Radiosensitive organs—including the brain, bone marrow, lens of the eye, and thyroid gland—can be exposed to radiation during CT of the head (Papadakis et al., 2011). In children younger than 5 years of age, about 20% of the active bone marrow is in the cranium, compared with 8% in adults (Cristy, 1981). CT-based radiation dose for pediatric patients is highly problematic because the developing cellular structures and tissues of children are significantly more radiosensitive than those of adults; children, therefore, will be at substantially elevated risk for malignancy (Hayes et al., 2012).

To conduct imaging studies with radiation dosing that is appropriate for children, many facilities follow policies and protocols using the concept of ALARA – As Low As Reasonably Achievable. ALARA principles deem any additional radiation beyond the minimum needed for interpretable images both detrimental and non-efficacious (American College of Radiology [ACR], 2009). Professional practice and patient advocacy groups including the ACR, the American Academy of Neurology (AAN), and the American Academy of Pediatrics (AAP) have developed and promoted ALARA protocols and policies; these guidelines support the use of CT imaging only when clinically indicated in children, decreasing the risk of harm from radiation.

Sedation and Anesthesia-Related Burden and Risk. Some children will require sedation to ensure minimal movement during CT studies. Use of sedation is necessary to avoid motion artifacts, which invariably occur if the child moves during image acquisition, thus interfering with image quality. Motion artifacts sometimes undermine imaging quality to the point of rendering images unreadable. In the case of CT imaging, this may result in additional radiation exposure to obtain images sufficient for interpretation. Although the sedation used for pediatric imaging has been identified as low risk, it does have potential attendant complications (Cravero et al., 2006; Malviya et al., 2000). Levels of sedation are on a continuum from minimal anxiolysis (administration of an anxiety reduction agent) to deep sedation, in which the patient can be roused only via vigorous stimuli (Arthurs & Sury, 2013). Compared with minimal sedation, moderate and deep sedation carry a greater risk of airway compromise, hypoxia resulting in central nervous system injury, and death (Cravero et al., 2006).

In certain instances, sedation may not be sufficient, and anesthesia will be required to complete imaging. Anesthesia includes administration of medication to the extent that there is some degree of respiratory suppression and potential for cardiac depression; the patient cannot be roused by external stimuli or commands (Arthurs & Sury, 2013). Administration of anesthesia raises risks related to the process of intubation for respiratory support. These risks include dental trauma; airway edema (swelling of the windpipe); vocal cord spasm or injury; regurgitation of stomach contents with subsequent aspiration (inhalation) pneumonia; injury to arteries, veins, or nerves; alterations in blood pressure; and/or irregular heart rhythms (Society for Pediatric Anesthesia, 2014). The most severe, though rare, risks include brain damage and death (Society for Pediatric Anesthesia, 2014).

Intravenous Contrast-Related Burden and Risk. During the course of CT studies, intravenous (IV) contrast media may be used to enhance visualization of vascular structures and provide important information about neurologic anatomy. It is possible a child may experience an allergic reaction to IV contrast or subcutaneous fluid leakage (extravasation) during administration of IV contrast. IV contrast administration also includes the risk of contrast-induced nephrotoxicity (CIN) (Bansal, 2014; Zo'o et al. 2011). Children with poor kidney function are at greater risk for developing CIN and, in rare cases, will develop renal failure requiring dialysis.

Cost-Related Burden. Overuse of imaging is costly and places additional strain on an already heavily burdened health care system (Callaghan et al., 2014). As an example, charges for a CT of the brain can be as much as $2,000 and can vary substantially by region of the country. In addition, the likelihood that neuroimaging will result in the identification of clinically important structural abnormalities in this patient population is low. Incidental findings, however, may require follow-up testing with associated charges and potential complications (Lumbreras et al., 2010; Rogers et al., 2013).

Performance Gap

Currently, professional guidelines do not support neuroimaging for atraumatic headache in the absence of documented neurologic signs or symptoms that suggest increased intracranial pressure because the yield is low and imaging without an indication exposes children to unnecessary risks.

While many children with headaches will not benefit from neuroimaging, children experiencing secondary headaches associated with trauma, new neurologic deficits, or signs and symptoms of increased intracranial pressure may require timely imaging. CT is usually the initial imaging modality of choice for patients who require timely imaging in the acute clinical setting (Hayes et al., 2012). CT imaging is readily available in most emergency departments (Ginde et al., 2008) and is the preferred imaging modality for post-traumatic headaches with features concerning for intracranial hemorrhage (Hayes et al., 2012). The ACR Appropriateness Criteria (Hayes et al., 2012) rank MRI as more appropriate than CT in patients with atraumatic headache. MRI may be a reasonable alternative to CT for children with atraumatic headaches, even for the evaluation of time sensitive conditions such as failure of a ventricular-peritoneal shunt (Boyle et al., 2014; Kim et al., 2015). MRI will usually be the preferred modality instead of CT because MRI does not use radiation and tends to have improved spatial resolution.

This measure assesses the number of CT scans obtained without indication on or within 30 days after the date of evaluation for atraumatic headache among children, ages 4 through 17 years old. For the purposes of this measure, indications include thunderclap headache, vascular disease, infections, lumbar puncture, new neurologic deficit, or signs and symptoms of increased intracranial pressure.

A lower percentage indicates better performance, as reflected by avoidance of radiation exposure from CT when it is not indicated.

Drivers of Overuse

Headache experienced by a child, especially when recurrent, can be a stressful event that may prompt a parent to seek the assistance of a health care provider, at times emergently. Some providers may feel pressured by the parent to order imaging despite the lack of benefit (Daymont et al., 2014; Raieli et al., 2010). This circumstance has a close parallel to parents who seek out antibiotics for their child who has viral respiratory symptoms. In these circumstances, the provider may deviate from established practice guidelines to placate the parent. In recent decades, this phenomenon has reached such wide-spread prominence as to prompt multidisciplinary initiatives targeted at fostering discussion and identifying common practices that should be questioned by parents and providers (AAP, 2013). An ongoing dialogue between providers and parents continues to be a key feature of optimal outcomes in the setting of headache.

The practice of defensive medicine is another reason an imaging study may be ordered without a clear indication. Physicians may be uncomfortable facing uncertainty regarding the etiology of headache in children they are evaluating and treating. Assurance behaviors (e.g., ordering additional tests) are

expected when a malpractice-sensitive physician is faced with a potentially worrisome condition that can cause the symptom in question (Carrier et al., 2013). In a survey of physicians from six specialties at high risk of liability, emergency physicians ordered more unnecessary diagnostic tests than clinicians from any other specialty (Studdert et al., 2005). Physicians practicing in the emergency department have the added challenge of limited access to detailed medical records, which increases uncertainty about prior evaluation of patients who are referred from an out-of-network provider or hospital. Overuse of neuroimaging is a potential result.

Evidence for Additional Information Supporting Need for the Measure

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Extent of Measure Testing

Reliability

To evaluate the reliability of using administrative claims for the calculation of this measure, the developer conducted a signal-to-noise analysis. This analysis was focused on assessing the ability to confidently distinguish the performance of one state health plan from that of another state. To perform the signal-to-noise analysis, the developer used the Medicaid Analytic eXtract (MAX) administrative claims data provided by the Centers for Medicare & Medicaid Services (CMS) from 2006 to 2010 for seven diverse state Medicaid programs: Colorado, Florida, Illinois, Massachusetts, Michigan, Texas, and Utah. The number of computed tomography (CT) scans per state and year are summarized in Table 9 in the original measure documentation. Proportion of CT imaging without indication varied between states, ranging from a low of 79.8% in 2006 (Michigan) to a high of 90.5% in 2006 (Texas). Lowest to highest proportion of CT imaging without indication within each state across the 5-year period were as follows: Colorado (81.5% to 84.8%); Florida (86.3% to 87.7%); Illinois (86.9% to 88.8%); Massachusetts (84.7% to 87.8%); Michigan (79.8% to 85.2%); Texas (85.1% to 90.5%); and Utah (81.9% to 88.9%).

For this approach, reliability was estimated with a beta-binomial model (RAND Corporation, TR-653-NCQA, 2009). The developer tested the reliability using aggregate data from these seven states, 2006-2010.

Reliability Results. Reliability results are detailed in Table 10 in the original measure documentation. These results show that the reliability based on signal-to-noise analysis ranged from 0.61 to 0.99, with a median of 0.96.

Reliability Conclusions. In general, reliability scores can range from 0.0 (all variation is attributable to measurement error) to 1.0 (all variation is caused by real differences). While there is not a clear cut-off for a minimum reliability level, values above 0.7 are considered sufficient to distinguish differences between some health plans and the mean; reliability values above 0.9 are considered sufficient to see differences between health plans (RAND Corporation, TR-653-NCQA, 2009). In states where the denominator is large (at least 2,000 events), the reliability is very good; observed reliability was consistently greater than 0.80. However, in Utah, where the denominator is 672 CT imaging events, reliability was lower (0.61). This suggests that this measure should be used in health plans with over 2,000 CT imaging events in the denominator to facilitate comparisons between plans; comparison of this measure among smaller health plans should be interpreted with caution.

Validity

Face Validity. Face validity is the degree to which the measure construct characterizes the concept being assessed. The face validity of this measure was established by a national panel of experts and parent representatives for families of children with headache and seizures convened by the Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). The Q-METRIC panel included nationally recognized experts in the area of imaging children, representing general pediatrics, pediatric radiology, pediatric neurology, pediatric neurosurgery, pediatric emergency medicine, general emergency medicine, and family medicine. In addition, face validity of this measure was considered by experts in state Medicaid program operations, health plan quality measurement, health informatics, and health care quality measurement. In total, the Q-METRIC imaging panel included 15 experts, providing a comprehensive perspective on imaging children and the measurement of quality metrics for states and health plans.

The Q-METRIC expert panel concluded that this measure has a high degree of face validity through a detailed review of concepts and metrics considered to be essential to appropriately image children. Concepts and draft measures were rated by this group for their relative importance. This measure received an average score of 7.3 (with 9 as the highest possible score).

Refer to the original measure documentation for additional information.

Evidence for Extent of Measure Testing

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: overuse of computed tomography scans for the evaluation of children with atraumatic headache. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC); 2016 May. 57 p.

State of Use of the Measure

State of Use

Current routine use

Current Use

not defined yet

Application of the Measure in its Current Use

Measurement Setting

Ambulatory/Office-based Care

Ambulatory Procedure/Imaging Center

Emergency Department

Hospital Inpatient

Hospital Outpatient

Managed Care Plans

Professionals Involved in Delivery of Health Services

not defined yet

Least Aggregated Level of Services Delivery Addressed

Single Health Care Delivery or Public Health Organizations

Statement of Acceptable Minimum Sample Size

Specified

Target Population Age

Age 4 to 17 years

Target Population Gender

Either male or female

National Strategy for Quality Improvement in Health Care

National Quality Strategy Aim

Better Care

National Quality Strategy Priority

Making Care Safer
Prevention and Treatment of Leading Causes of Mortality

Institute of Medicine (IOM) National Health Care Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Safety

Data Collection for the Measure

Case Finding Period

The measurement year

Denominator Sampling Frame

Enrollees or beneficiaries

Denominator (Index) Event or Characteristic

Clinical Condition

Diagnostic Evaluation

Encounter

Patient/Individual (Consumer) Characteristic

Denominator Time Window

not defined yet

Denominator Inclusions/Exclusions

Inclusions

The denominator is the number of computed tomography (CT) scans obtained on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years of age.

Note:

> Eligible children must be ages 4 through 17 years old during the measurement year for which CT imaging of the head is obtained and must be continuously enrolled in their insurance plan during both the measurement year and the year prior.
> Table 1 in the original measure documentation lists Current Procedural Terminology (CPT) codes associated with CT imaging of the head. International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes to identify atraumatic headache are shown in Table 2 of the original measure documentation. Headache must occur on the day of or up to 30 days prior to imaging. Atraumatic headaches are those not associated with trauma occurring in the 7 days prior to imaging.

Exclusions

Exclusions based on ICD-9-CM or CPT codes captured in administrative claims data:

- Trauma-related headache or pain (refer to Table 2 in the original measure documentation) on the day of or within 7 days prior to imaging
- Head trauma or suspected abuse/neglect (refer to Table 7 in the original measure documentation or the presence of an E-code in claims data) on the day of or within 7 days prior to imaging
- Imaging study obtained on the day of or within 180 days following neurosurgical intervention (refer to Table 6 in the original measure documentation)

Exclusions/Exceptions

not defined yet

Numerator Inclusions/Exclusions

Inclusions
The numerator is the number of computed tomography (CT) scans obtained without indication on or within 30 days after the date of evaluation for atraumatic headache among children ages 4 through 17 years old.

Exclusions
Exclusions based on International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or Current Procedural Terminology (CPT) codes captured in administrative claims data:

- New neurologic deficits or signs or symptoms of increased intracranial pressure (refer to Table 3 in the original measure documentation for a list of codes) between the date of diagnosis and imaging study
- Thunderclap headache (refer to Table 2 in the original measure documentation) on the day of or within 365 days prior to imaging
- Vascular disease (refer to Table 4 in the original measure documentation) on the day of or within 365 days prior to imaging
- Infections that would warrant imaging on the day of or within the 365 days before the atraumatic headache (refer to Table 5 in the original measure documentation)
- Lumbar puncture (refer to Table 6 in the original measure documentation) during the visit (same date/date after) where imaging was obtained

Numerator Search Strategy

Fixed time period or point in time

Data Source

Administrative clinical data

Electronic health/medical record

Paper medical record

Type of Health State

Does not apply to this measure

Instruments Used and/or Associated with the Measure

Unspecified

Computation of the Measure

Measure Specifies Disaggregation

Does not apply to this measure

Scoring

Rate/Proportion

Interpretation of Score

Desired value is a lower score

Allowance for Patient or Population Factors

not defined yet

Standard of Comparison

not defined yet

Identifying Information

Original Title

Overuse of computed tomography scans for the evaluation of children with atraumatic headache.

Measure Collection Name

Overuse of Imaging for the Evaluation of Children with Headache or Seizures

Submitter

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) - Academic Affiliated Research Institute

Developer

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) - Academic Affiliated Research Institute

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Financial Disclosures/Other Potential Conflicts of Interest

Unspecified

Adaptation

This measure was not adapted from another source.

Date of Most Current Version in NQMC

2016 May

Measure Maintenance

Unspecified

Date of Next Anticipated Revision

Unspecified

Measure Status

This is the current release of the measure.

Measure Availability

Source available from the Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) Web site . Support documents also available from the Q-METRIC Web site .

For more information, contact Q-METRIC at 300 North Ingalls Street, Room 6C06, SPC 5456, Ann Arbor, MI 48109-5456; Phone: 734-232-0657.

NQMC Status

This NQMC summary was completed by ECRI Institute on June 28, 2016. The information was verified by the measure developer on July 1, 2016.

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Production

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